Derivative Process Model of Development Power in Industry: Empirical Research and Forecast for Chinese Software Industry and US Economy

Feng Dai Bao-Hua Sun Jie Sun

Zhengzhou Information Engineering University
No.770, P.O.Box 1001, Zhengzhou, Henan 450002, China
E-mail: fengdai@public2.zz.ha.cn

Abstract: Based on [1], this paper analyzes the transferability and the diffusibility of industrial development power, puts forward the index of management strength, and sets up the derivative process model for industrial development power on the Partial Distribution [2]-[3]. By the derivative process model, a kind of time series model, we can describe the process of industrial development effectively, and can forecast the future direction of industry or economy on using with [6]. Finally, by making use of the actual data of Chinese software industry and data of USA GDP (chained) price index, we give the examples of empirical analysis, and forecast the future of Chinese software industry and USA economic development. The conclusions in this paper are believed to be valuable and significant to guide the establishment of the industrial policy and to control the industrial development.

Keywords: development power (*DP*), partial distribution, derivative process, industry and macroeconomy, empirical research, forecast analysis

1 INTRODUCTION

Starting from the actual cases of industrial development, development power (*DP*) is put forward in [1], and the development energy is the measurement for *DP*. In this paper, the authors will point out that the development power (*DP*) is the basic motivity to push forward industrial productivity. It is the continuous movement of *DP* which pushes the progress of the industrial productivity gradually, and impels the industry to develop continuously. Productivity is the human's behavior ability and "hardware" to reform nature and society. But, this behavior ability must be forced by some motivity, otherwise, this kind of behavior ability should be no change. This latent motivity concealed behind industrial productivity is, we say, the *DP*. So the *DP* is the behavior motivity and "software" of human's reforming the nature and the society. Speaking from the extensive meaning, policies, technologies, knowledge, management and so on are all the contents of *DP*.

Here, author will also explain that the *DP* and *DP* of industry (*DPI*) are all existent, describe the concept of *DPI*, discuss the characters of *DPI*, give the movement process models of *IDP*, and carry out the empirical research and forecast about Chinese software industry and USA economic development. It is believed that the research results here will offer a kind of basic theory and a practical tool to analyze the macro-process of industrial and economic development.

2 THE ESSE OF INDUSTRIAL DEVELOPMENT POWER

We shall show that the *DP* does take the role to impel industrial progressing by three cases, so the *DPI* (*DP* of industry) is a kind of motivity concealed in industrial productivity.

Case 1 If trying to exist and to develop in the modern economic society, the business enterprises need to hold the related producing technique and own the producing bankroll first, namely accumulates the necessary economic power, in order to form the necessary producing ability. When it got the related producing technique and producing bankroll, it can be converted to the actual production ability (include purchasing the equipments, recruiting the employees, and using the techniques), and can produce the merchandises and sell them, namely release the economic power accumulated already. Later, three kinds of processes that economic power is accumulated and released would come to the enterprises:

- If there are new need for merchandises in market, the enterprise must hold the new producing techniques and own the new producing bankroll, and use them.
- If other enterprise also use the same techniques to produce the same merchandises, it has to hold another new technique and use them in order to win the competition advantage.
- If the enterprise whose products are the same are too many to the economic society, it has to hold other new techniques and use the techniques.

Case 2 When an industry starts or goes on its developing stage, many new problems will be appeared, such as raw and processed materials, human resource management, market developments, industrial system, planning the production, production organizing, enterprises management, and so on. All of these problems need to be solved, and the industry progress in the solving process. So we think all these problems are the motivity to push an industry forward. When the problems become more and more serious, the demand of solving problem also become more and more urgent. In this process, the development power of industry (*DPI* for short) has already been accumulating. At the time that, all of the problems have been solving, new industrial mechanism is gradually formed, and the development of whole industry is going with a swing orderly, *IDP* accumulated before starts releasing. As soon as the new industrial mechanism puts out in action, the *DPI* releases completely. Subsequently, other new problems appear, and a new process that *DPI* is accumulated and released starts.

Case 3 In the development process of an industry, the movement of *DPI* is not the single. In many cases, the *DPI* on which enterprises develop is a synthesized moving process, i.e. many kinds of *DPI* exist. For example, in the

processes of industry developing and managing, some enterprises develop from small to big, some from a company to group company, some from a native company to multinational company, will have the different cycle of *DPI* movement; Again for example, the an industry develop, produce and sell its different products also will have the different cycle of *DPI* movement. In addition, the market constructing of an industry has a movement of market *DP*, the product developing and producing of an industry will have the movements of techniques *DP*, capitals *DP*, equipment *DP*, and so on.

All of the above cases make know that *DPI* exists for sure in the process of industrial development. Actually, besides of industry, there are the analogous movements of *DP* in the nature evolving, society development, and in the progress of agriculture, science and technology, education, and in policy making, etc.

In another hand, there is the different *DP*'s movement process in constructing and operating different enterprise, and the different *DP* in industry are mutually interlaced one with another. One accumulation process and one release process of *DPI* constitute one movement cycle of *DPI*, namely a derivative process.

3 THE BASIC THEORY OF *DPI*

Here, we give the definitions of *DP* and *DPI*, the basic properties of *DPI*, and the measuring index of *DP* and *DPI*.

A. The Basic Concepts

Definition 1 The development power (*DP*) is the latent motivity which can impel visible resources to convert to the visible productivity or social and economic products.

The formation and movement of *DP* depend on three essential factors:

- the need of making use of the society and economic resources reasonably
- the desire to expect that the economic society develop positively and orderly
- the demand to acquire the social services and economic products more and the better

Generally, the capitals, policies, technique, information, consciousness, idea, management, culture, spirit are all the *DP* in economy and society. There are two basic ways in the movement of *DP*, i.e. accumulation and release of *DP*. Although people usually feel the esse of *DP*, have no the real paying attention to it, and to say nothing of taking it into a deep research.

In industry, *DP* can push the industrial productivity and the industrial management to progress. In fact, the desire that the enterprises or the industry always work hard for better development and in the reasonable way is the invisible motivity to convert the visible enterprise resources to industrial productivity and products, and impels the enterprises to develop. So we have

Definition 2 The development power in industry management is, *DPI* for short, the latent motivity which can impel the visible resources of industry to convert to its visible productivity or products.

DPI is a kind of *DP*. The *DPI* is strong or weak can reflect that the efficiencies of industrial production are high or low, and usage of industrial resources is better or less, also effect that the industrial development is reasonable or not.

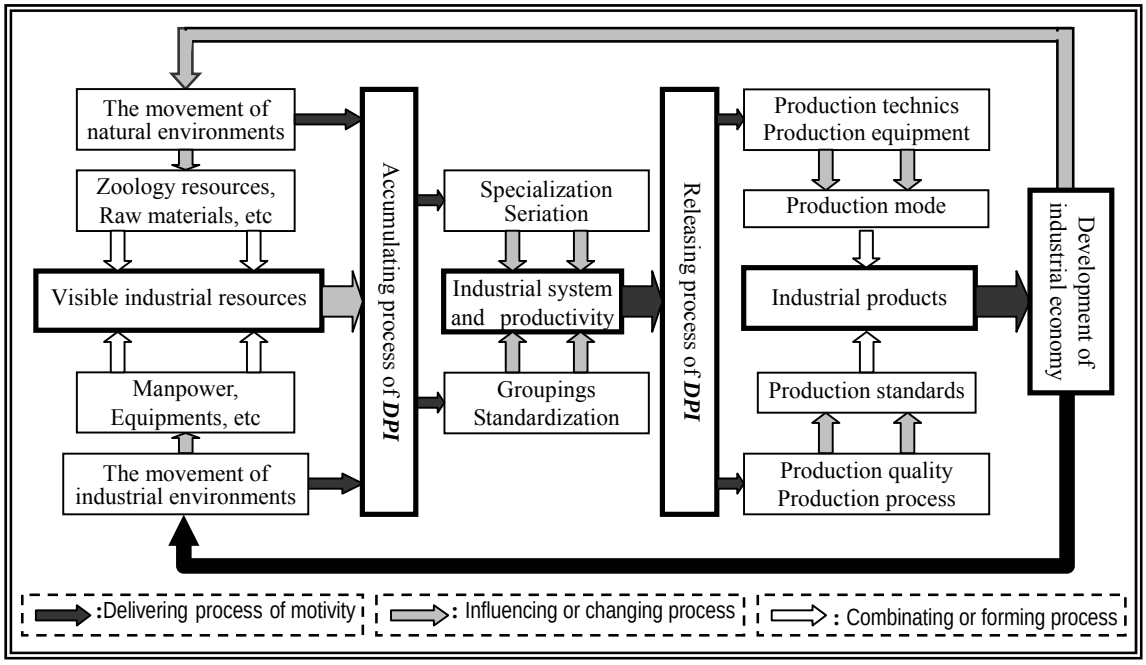

Figure 1 The Principle of *DPI* Pushing an Industry to Progress

The principle of *DPI* pushing an industry to progress can be described by figure 1. In figure 1, along with the *DPI* accumulating, the industrial mechanism and equipments, and the innovation of techniques of production and product, will be caused, and along with the application of the new managing mechanism, *DPI* accumulated will be released effectively, to push the industry to develop.

B. The Basic Properties

In general, the movement of *DPI* has four basic properties as follow:

1. Invisibility: *DPI* is an invisible and non material force, and this point has been discussed in the anterior cases and the definition 2.

2. Fluctuation: the movements of *DPI* include two basic ways, i.e. accumulation and release. So the *DPI* could be strong or weak, that *DPI* alternates between strong and the weak determines the fluctuation of *DPI* movement.

3. Diffusibility: *DPI* could move, transfer and diffuse from anindustrial field to other related industrial fields. For instance, the development of the computer industry makes the computers being used widely, and the usage of computer causes other industries, such as manufacturing control, weather analysis, spaceflight engineering, scientific simulation, etc. to develop. As for manufacturing control, the application of computers can bring about an advance in technique ability of manufacturing control, i.e. the *DPI* of manufacturing control being accumulated efficiently, so that the productivity of manufacturing control is propelled forward; and if the products of manufacturing control based on computer are applied to producing process, and achieve a good actual results, thus *DPI* of manufacturing control starts releasing. Further more, the development of manufacturing control will propel the its downstream industries forward, such as spin and weave, paper making, steel industry, machine and electronics, etc. On the other hand, the higher request to computer from manufacturing control will accumulate the *DPI* of computer industry. All of that are the diffusing process of *DPI*, and can be described by figure 2.

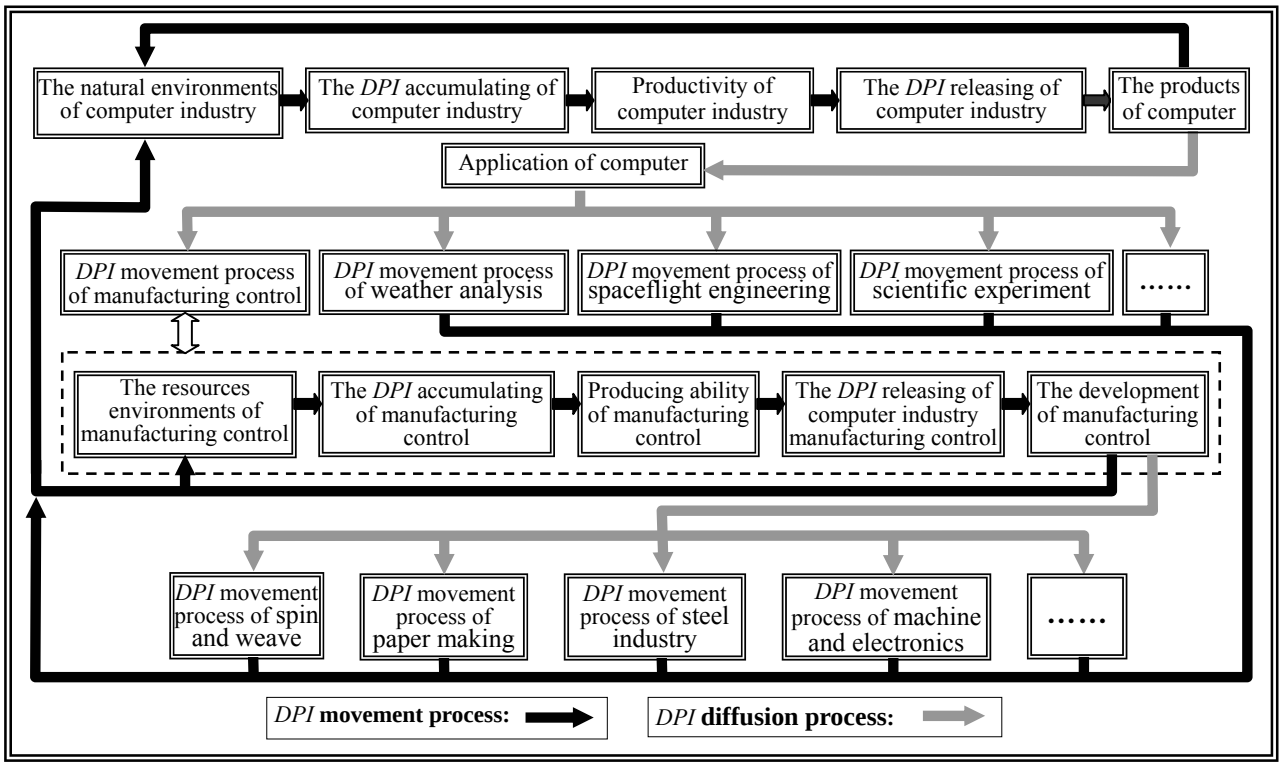

Figure 2 *DPI* movement and diffusion process in computer industry

4. Continuity: *DPI* will be released after it has been accumulated sufficiently, and *DPI* needs to be accumulated after it has been released sufficiently. The process, from start of accumulating to end of releasing, is called a complete cycle of *DPI* movement. Because society and economy develop endlessly, a new cycle of *DP* movement starts after a cycle ends, this process will keep on continuously until an industry is fallen into disappear thoroughly. At this time, *DPI* is never accumulated in this industry.

C. The Basic Assumptions and Measurements

From the definitions and basic properties, we give the basic assumptions about the *DPI* here.

Assumption

The assumptions about the level of industrial development are as follows:

1) The level of industrial development is the synthesis

status of an all fields in industry. It could include the basic level and the actual level. The basic level is the level to which industrial development should attain corresponding to economic status, so we could measure the basic level of industrial development by means of the production value supported by industrial basis. The actual level of industrial development is the current and real level on industrial production, so we could measure the actual level of industrial development by means of the real production value.

2) Both the basic level and the actual level of industrial development are nonnegative. Namely in theoretical, the lowest values of the basic level and the actual level of industrial development are the zero.

3) Both of two levels of industrial development have been fluctuating and will fluctuate in future, and the fluctuation range is positive, namely, the lowest fluctuation value is larger than zero. The actual level should fluctuate around its basic level.

4) The more the actual level is far from the basic, the less the possibility is. The more the actual level is far from the basic, the less the possibility is. The possibility, the actual level is much lower or much higher than the basic level, will be very small.

5) The actual level can't be of foreknowledge accurately, so it is a stochastic variable.

Measurement index

Here, we give the rules about the measurement of the levels of *DPI* as follows

1) The measuring index of *DPI* is the development energy of industry, which is the fluctuating range of the level of basic level of industrial development, namely standard variance of the basic level.

2) In general, we do measure *DPI* with the relative development energy. The relative development energy (*DEI*) also called the development vitality of industrial development (*DVI*). *DVI* is the ratio of standard variance of the actual level to the actual level, namely

$$DEI = \frac{\text{The standard variance of the actual level}}{\text{The actual level}} \quad (1)$$

If *DPI* is continually accumulated when the basic level increases gradually, namely *DEI* continuously strengthen, and we call this kind of process the growth process with *DPI* accumulation. And if *DPI* is continually released when the basic level increases gradually, namely *DEI* continuously weaken, and we call this process the growth process with *DPI* release. To the case that the basic level declines gradually, we have the recession process with *DPI* accumulation and the recession process with *DPI* release. If the basic economy level is stable, we have the stable process with *DPI* accumulation, or the stable process with *DPI* release.

4 THE BASIC MODELS OF *DPI* MOVEMENT

In order to analytic and utilize *DPI*, we give the describing model, process model and forecast model of *DPI* here.

A. Describing Model

Denote

μ——The basic level of industrial development.

σ——The standard variance of the basic level of industrial development, could describe the absolute energy of industrial development.

$v=\sigma/\mu$——The fluctuating ratio of the basic level of industrial development, could measure the development energy.

X——The actual level of industrial development, a nonnegative variable.

According to the anterior assumptions, X follows the partial distribution [2]-[3]:

$$f(x)=\begin{cases} e^{-\frac{(x-\mu)^2}{2v^2}} \Big/ \int_0^{\infty} e^{-\frac{(x-\mu)^2}{2v^2}}\,dx & x\geq 0 \\ 0 & x<0 \end{cases} \quad (2)$$

And note as $X\in P(\mu, \sigma^2) X\in P(\mu, v^2)$. If μ, v, X are all time variant, note respectively as $\mu(t)$, $v(t)$, $X(t)$, thus $X(t)\in P(\mu(t), v^2(t))$.

From [2] and [3], we have the following results:

1) The average value of actual level of industrial development:

$$E(X)=\mu+\sqrt{\frac{2}{\pi}}\sigma\frac{e^{-\frac{\mu^2}{2\sigma^2}}}{\sqrt{1-e^{-\frac{2}{\pi}(\frac{\mu}{\sigma})^2}}+1} \quad (3)$$

where, $R(X)=\sqrt{\frac{2}{\pi}}\sigma\frac{e^{-\frac{\mu^2}{2\sigma^2}}}{\sqrt{1-e^{-\frac{2}{\pi}(\frac{\mu}{\sigma})^2}}+1}$ can expresses the average increment of actual level exceeding the basic level in production value of industrial development

2) The real average energy of *DPI*:

$$v(X)=\sqrt{D(X)}\Big/E(X) \quad (4)$$

where, $D(X)=\sigma^2+E(X)[\mu-E(X)]$.

B. Time Series Models

We know that the types of *DPI* movement include the growth process of industrial development with *DPI* accumulation or with *DPI* release, and the recession process of industrial development with *DPI* accumulation or with *DPI* release.

Suppose that the process of industrial development has n stages (integer $n>0$), the initial value $\mu_0=\mu$, $\sigma_0=\sigma$, and $X_0\in P(\mu, \sigma^2)$. On ith stage (i= 1, ···, n, $n>0$), μ_i is the actual level of i-1th stage, and take as the basic level of ith stage, $v_i=\sigma_i/\mu_i$ is *DVI* of ith stage.

1) The model of growth process with *DPI* accumulation. In the process that the basic level increases gradually with *DPI* accumulation, the movement of *DPI* is full of vitality, so we suppose that there are the following relations (5) between the basic level of industrial development and *DVI*:

$$v_i=\alpha e^{\beta\mu_i} \quad (5)$$

where, $\alpha,\beta>0$,and the actual level of industrial development

$X_i \in P(\mu_i, v_i^2)$.

When $\mu_i > \mu_{i-1}$, we have $v_i > v_{i-1}$, so the movement of *DPI* is accumulating with growth of basic level. At this time, the movement of *DPI* is, described by Partial Distribution, shown in figure 3 (n=5).

2) The model of growth process with *DPI* release. After the *DPI* has been accumulated sufficiently, the new industrial mechanism forms and starts being applied, *DPI* starts being released. At this time, the development energy accumulated before will keep on impelling the industrial development to heighten, and the development energy minishes gradually, i.e. *DPI* release gradually. So we suppose that there are the following relations (6) between the basic level of industrial development and *DVI*:

$$v_i = \alpha e^{-\beta \mu_i} \tag{6}$$

where,α,β>0, and the actual level of industrial development $X_i \in P(\mu_i, v_i^2)$.

When $\mu_i > \mu_{i-1}$, we have $v_i < v_{i-1}$, so the movement of *DPI* is releasing with growth of basic level. At this time, the movement of *DPI* is, described by Partial Distribution, shown in figure 4 (n=5).

3) The models of recession process with *DPI* accumulation or with *DPI* release. The expression (5) and (6) can describe respectively the recession process with *DPI* accumulation and with *DPI* release, the difference is of reverse to the growth process, i.e. replace the i (i=1, 2, ⋯, 5) in Figure 3 and Figure 4 by the i (i=5, 4, ⋯, 1).

4) The derivative process model of *DPI*. Combining the process with *DPI* accumulation with the process with *DPI* release, we have a whole process of *DPI* movement, this whole process is called a derivative process, a kind of time series model; if we describe a derivative process by Partial Distribution, the model of a derivative process is given, see in figure 5. A derivative process reflects one or more complete cycle of *DPI* movement. The derivative process also includes many of whole process linked one after another.

In actual, the α in expression (5) and β in expression (6) could be estimated by least square method.

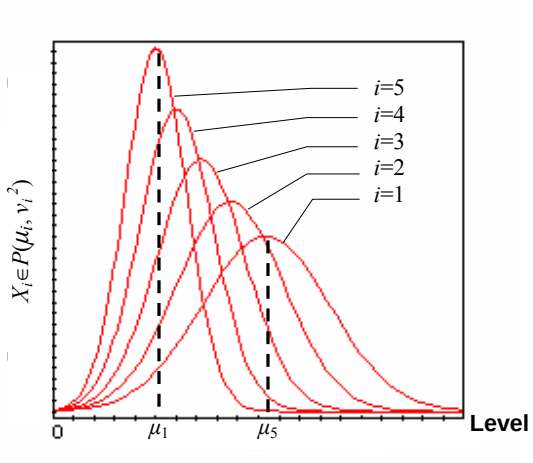

Figure 3 The process of growth process with *DPI* accumulation

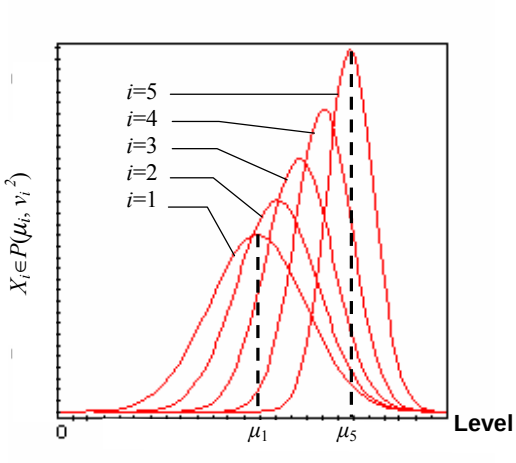

Figure 4 The process of growth process with *DPI* release

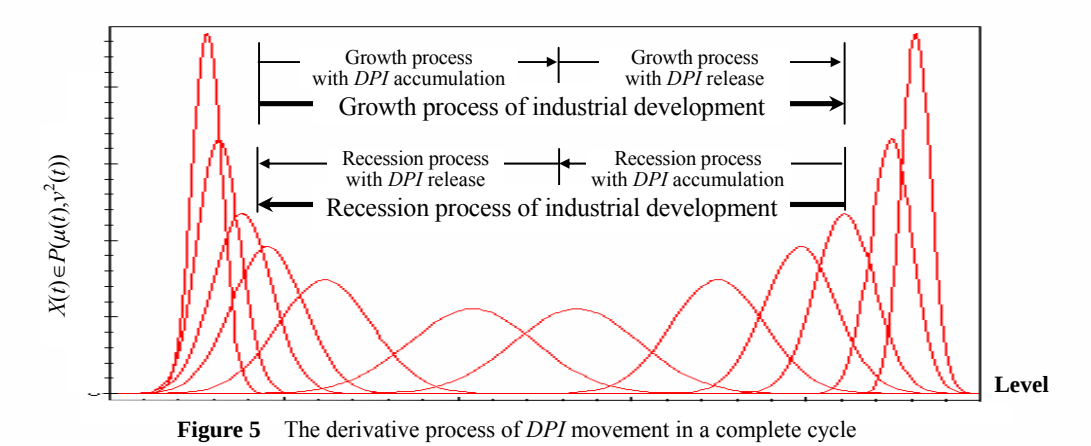

Figure 5 The derivative process of *DPI* movement in a complete cycle

C. Forecast Models

Suppose that the actual level of industrial development is $X \in P(\mu, v^2)$, according to [6], we take l as the significance level of releasing *DPI*, and

$$l=\frac{\mu+\sqrt{\mu^2+2v^2}}{\sqrt{2\pi}k\left(1+\sqrt{1-e^{-\frac{2}{\pi}\left(\frac{\mu}{v}\right)^2}}\right)}$$

where k (≥1) is the adjusting and controlling strength to which the industrial development should attain, A-C strength for short. Adjusting and controlling to an industry include both management's strength and policy's strength. In the growth process of an industry, the larger the k is, the larger the A-C strength is in order to support the development of the industrial production; and in the recession process of an industry, the larger the k is, the larger the A-C strength is in order to avoid the continuous recession of the industrial production; if k=1, the A-C strength is at the lowest level, means that the industrial development is under the natural status on itself.

According to [6] and in the growth process, the possible maximum production value of an industry should be:

$$X_{MAX}=\mu+\frac{2kv^2}{\mu+\sqrt{\mu^2+2v^2}}+2v\sqrt{(k-1)\left(\frac{\mu}{\mu+\sqrt{\mu^2+2v^2}}+\frac{(k+1)v^2}{(\mu+\sqrt{\mu^2+2v^2})^2}\right)} \quad (7)$$

And in the recession process, the possible minimum production value of an industry should be:

$$X_{MIN}=\mu+\frac{2kv^2}{\mu+\sqrt{\mu^2+2v^2}}-2v\sqrt{(k-1)\left(\frac{\mu}{\mu+\sqrt{\mu^2+2v^2}}+\frac{(k+1)v^2}{(\mu+\sqrt{\mu^2+2v^2})^2}\right)} \quad (8)$$

The equilibrium value of industrial production should be:

$$X_E=\mu+\frac{2kv^2}{\mu+\sqrt{\mu^2+2v^2}} \quad (9)$$

By use of expression (7), we can forecast the possible maximum production value under the growth process of industry; by use of (8), we can forecast the possible minimum production value under the recession process of industry; and by use of (9), we can forecast the possible equilibrium production value. Of course, according to [7], we can forecast the production value with maximum probability.

5 THE EMPIRICAL ANALYSIS AND FORECAST FOR *DPI* MOVEMENT IN CHINESE SOFTWARE INDUSTRY

Based on the sale data of Chinese software market from "2003—2004 annual research report of Chinese computer market" (SAIDY ADVISOR Ltd., http://industry. ccident. com, i.e. [9]), we shall give the empirical analysis and forecast for *dpi* movement in Chinese software industry here. For the analytic needs, the sale data, the original data divided by 100, express the basic levels of industrial development. The corresponding data are seen in table 1.

Table 1 related data and index of *DPI* in Chinese Software Industry

year (t)	**Annual sale** (one hundred million RMB) $\lambda(t)$	**Basic Level of *DPI*** $\mu(t)$	**Absolute development Energy** $\sigma(t)$	**Development Energy** (*DEI* or *DVI*) $v(t)$
1998	138	1. 38	–	–
1999	176	1. 76	0. 38	0. 216
2000	230	2. 30	0. 54	0. 235
2001	285	2. 85	0. 55	0. 193
2002	345	3. 45	0. 60	0. 174
2003	399	3. 99	0. 54	0. 135

In table 1,

$\lambda(t)$—the annual sale of Chinese Software Industry at year t (unit: one hundred million RMB).

$\mu(t)=\lambda(t)/100$—the basic level of Chinese Software Industry, t=1998, 1999, 2000, 2001, 2002, 2003.

$v(t)=\sigma(t)/\mu(t)$ —the *DEI* or *DVI* of Chinese Software Industry , where $\sigma(t)=|\mu(t)-\mu(t\text{-}1)|$, t=1999, 2000, 2001, 2002, 2003.

Suppose that the actual level of Chinese Software Industry satisfies the Partial Distribution, i.e. $X(t)\in P(\mu(t), [v(t)]^2)$ (t=1999, 2000, 2001, 2002, 2003), also see figure 6. We can see that there is a growth process with *DPI* accumulation for Chinese Software Industry from 1999 to 2000. And there is a growth process with *DPI* release for Chinese Software Industry from 2000 to 2003.

From the data of $\mu(t)$ and $v(t)$ in table1 and under the consideration that Chinese software industry is going on a process of growth process with *DPI* release, we have the following estimating result by using expression (6) and least square method:

$$\overline{v}(t)=\alpha e^{-\beta\overline{\mu}(t)}$$

where, $\alpha=e^{-0.7389126583}$, β=0.3087988760

And by use of expression (7), we have estimated the $\overline{\mu}(t)$ (t=2000, 2001, 2002, 2003, 2004), see in table 2. Figure 7 show the comparisons between real and forecasting results. In table 2, the values of $\overline{\mu}(t)$ (t=2000, 2001, 2002, 2003, 2004) are estimated separately on the management strength k=2.5, 3.5, 4.5, 5.5, 6.5, this means that the

management level should be higher gradually along with the further development of Chinese Software Industry.

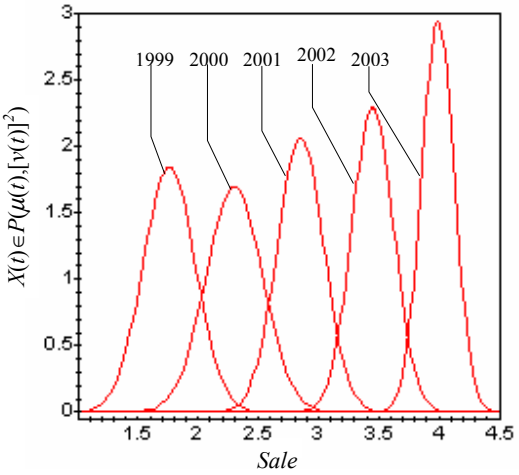

Figure 6 The Partial Distribution curves of Chinese Software Industry from 1999 to 2003

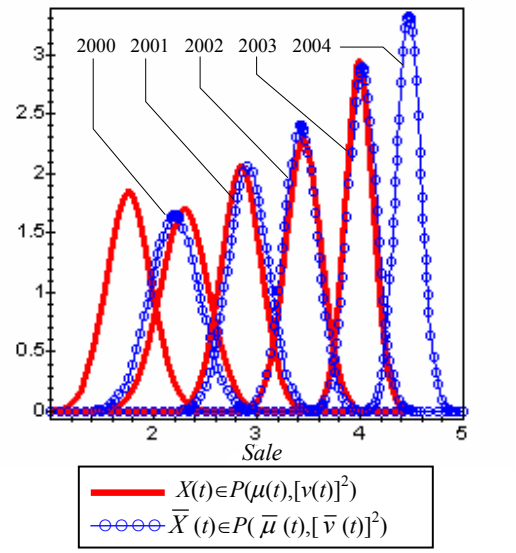

Figure 7 The comparisons analysis between reality and forecast on *DPI* of Chinese Software Industry from 2000 to 2004

Table 2 The related data, estimation and estimating error of *DPI* about Chinese Software Industry

Year t	The real data of *DPI*		The estimating data of *DPI*		Error comparison		A-C strength
	Basic level $\mu(t)$	*DEI* $v(t)$	Basic level $\bar{\mu}(t)$	*DEI* $\bar{v}(t)$	$\mu(t)$- $\bar{\mu}(t)$	$v(t)$- $\bar{v}(t)$	k
1999	1.76	0.216					
2000	2.30	0.235	2.203141152	0.2418977483	-0.096858848	-0.0068977483	2.5
2001	2.85	0.193	2.913156231	0.1942727794	0.063156231	-0.0012727794	3.5
2002	3.45	0.174	3.421867901	0.1660308574	-0.028132099	0. 0079691426	4.5
2003	3.99	0.135	4.021711085	0.1379570987	0.031711085	-0.0029570987	5.5
2004			4.469525682	0.1201400462			6.5

The average estimating errors in table 2 are:

$$s_1 = \frac{1}{4}\sqrt{\sum_{i=2000}^{2003}[\mu(t)-\bar{\mu}(t)]^2} = 0.\ 01516735385,$$

$$s_2 = \frac{1}{4}\sqrt{\sum_{i=2000}^{2003}[v(t)-\bar{v}(t)]^2} = 0.\ 0001214505655$$

Both the s_1 and s_2 are smaller, so we could be faith in the estimating results $\bar{X}(t)$ (t=2000, 2001, 2002, 2003, 2004). Because $\bar{X}(2004) \in P(4.469525682,\ 0.1201400462^2)$, we could think, at 2004, that the annual sale of Chinese Software Industry is about $\bar{\mu}(t)$ =447 hundreds million R.M.B., and the development energy of industry is v=0.1201400462.

Here, the precondition of forecasting results is that Chinese software industry is still in the high speed growth with *DPI* release, owing to estimating values of the basic level by expression (7) are the annual top limit of industrial growth. moreover, what we need to explain is: Because *DPI* releases gradually, the vitality (the development energy of industry) $v(t)$ or $\bar{v}(t)$ becomes small and small, and means that it is more and more difficult for Chinese software industry to keep on developing in high speed, this point is also explained from the A-C strength index k becomes larger and larger (see the table 2). So the two aspects as follows should be noticed in the future development of Chinese software industry:

1. Paying attention to the accumulation of *DPI* for software industry, namely enhancing effectively the researches of software theories and techniques, perfecting the related policies and laws, constructing the normal software market,

etc.

2. Improving effectively the management level and management quantity of software industry.

6 THE EMPIRICAL ANALYSIS AND FORECAST FOR *DP* MOVEMENT IN AMERICAN ECONOMY

We could take the national economy as a synthesis industry. American economy has been increasing From World War II to 2003. According to *DP* and derivative process theory, we can discover that there are many different characteristics at each of periods in that development process. Further more, we can forecast approximately the US economic developing trend in next years by use of *DPE* (Development Power in Economy) movements or *DE* (Development Energy).

A. Data and Models

Here, we analyze the U.S. economic development mainly according to American GDP in the period of 1940-2003. Because the absolute difference is too big between 1940 and 2003 in GDP values on the U.S.$, this does not benefit to objectively describe the undulating range on the same foundation, so we use the GDP (chained) price index (the GDP index for short) to give the empirical analysis. Data resource: http://www.whitehouse.gov, Fiscal Year 2000 = 1.000, i.e.[10].

Taking the following notations and expressions:

$\mu(t)$——The basic level in economy, namely the GDP index at the year t, t=1940,1941,· · ·, 2003.

$\sigma(t)$——The standard variance of the basic level in economy, could describe the absolute energy of economic development. $\sigma(t)=|\mu(t)-\mu(t\text{-}1)|$, t= 1941,1942,· · ·, 2003

$v(t)$——The fluctuating ratio of the basic level in economy, could describe the development energy of economy (*DE*). $v(t)=\sigma(t)/\mu(t)=|\mu(t)-\mu(t\text{-}1)|/\ \mu(t)$, t=1941,1942,· · ·, 2003.

$X(t)$——The actual level of industrial development, a nonnegative variable. $X(t)\in P(\mu(t),[\ v(t)]^2\ )$.

The interval of time unit for sampling data GDP is a year, the stability of data is higher, and the difference between GDP price index of one year and that of last year can nicely describe the economic fluctuation at that time, so we adopt the formulas about $v(t)$ above. The basic levels and development power in US economy are drawn in figure 8. In figure 8, the proportion of the real indexes of μ (t) to drawn indexes is 1:10.

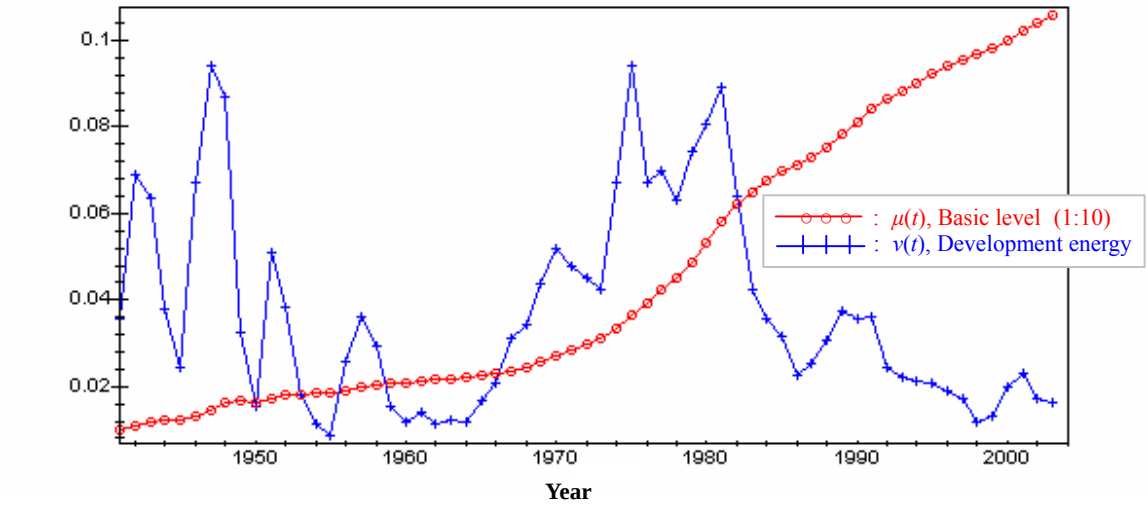

Figure 8 The GDP indexes and *DE*s of US economy (1941-2003)

B. Analysis of DPE Movement

Analysis of macroscopic energy

From figure 8, we have drawn the partial distribution curves of $X(t)$ (the variable of U.S. actual economy level) according to local top values of $v(t)$ on the years (t=1942,1951,1947,1957,1961,1970,1977,1981,1989,2001), see figure 9.

From figure 9, we see that the process of US economic development from 1942 to 2001 can be divided as three stages.

First stage: 1942-1963, this is a growth process with *DPE* release.

Second stage: 1963-1977, this is a growth process with *DPE* accumulation.

Third stage: 1977-2001, this is a growth process with *DPE* release also.

In order to check the characteristic of derivative process that exists in the economic development, we also have drawn the partial distribution curves of $X(t)$ according to local bottom values of $v(t)$on the years (t= 1941, 1945, 1950, 955, 1962, 1973, 1978,1986, 1998, 2003), see also figure 10. From figure 10, we also see that the process of U.S. economic development from 1941 to

2003 can be divided as four stages. First stage: 1940-1955, this is a growth process with *DPE* release.

Second stage: 1955-1978, this is a growth process with *DPE* accumulation.

Third stage: 1978-1998, this is a growth process with *DPE* release also.

Fourth stage: 1998-2003, this is a growth process with *DPE* accumulation also.

There is no marked *DE* movement between 1986 and 1998 in figure 10. If drawing the distribution curves of $X(t)$ this 13 years, we get the results shown in figure 11. It is worthy to point out that, there is another whole derivative process in figure 11, includes a growth process with *DE* accumulation and a growth process with *DPE* release. There are the similar movement characteristics between other two top values or two bottom values of *DE*.

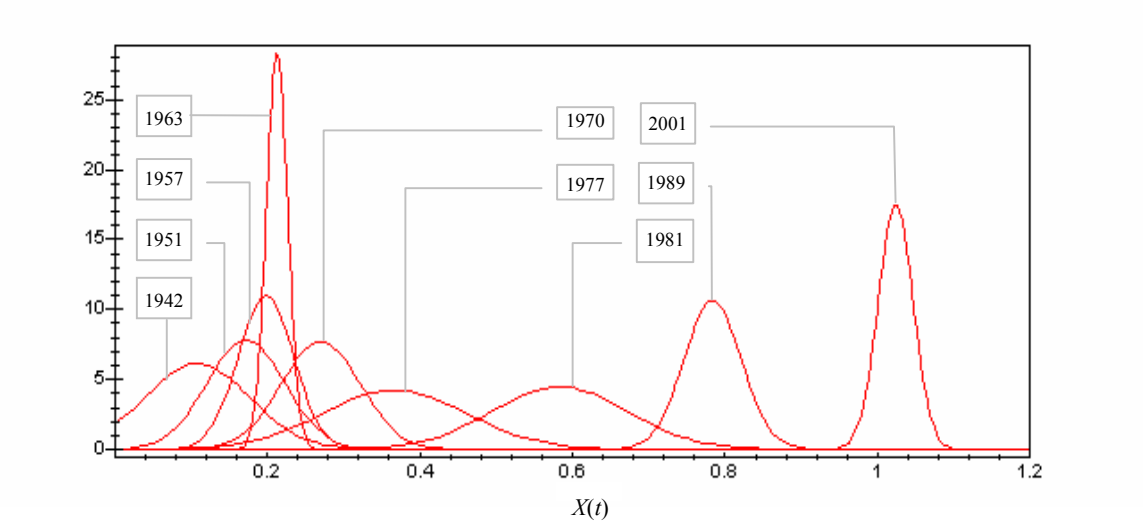

Figure 9 The Partial Distribution curves of US actual economic level on the years having the *DEs* [i.e. $v(t)$] at local tops

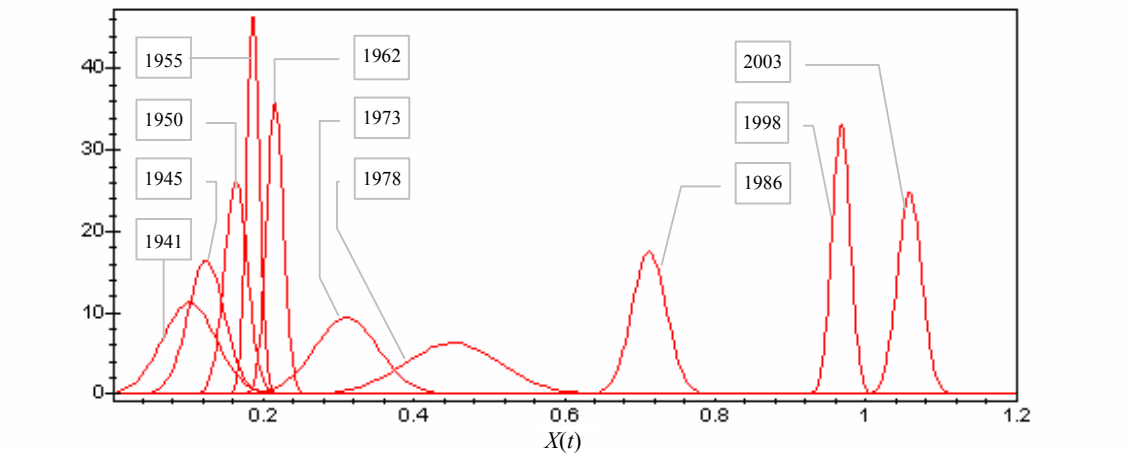

Figure 10 The Partial Distribution curves of US actual economic level on the years having the *DEs* [i.e. $v(t)$] at local bottoms

Making a sum from above discussions, we get a conclusion that the *DPE* movement and derivative process always exist in the economic development. If there are differences in derivative process are different, it must be different in the length of time, not the macroscopic structure.

Analysis of average energy

From figure 8, we see that the *DE* fluctuating extent of US economy becomes small gradually after 1983. The related analyses are following:

Between 1941and 2003:

The average value of *DE* on local tops is

$E^{\max}_{1941-2003}$ =[(v(1942)+v(1947)+v(1951)+v(1957)+v(1961)+v(1970)+v(1977)+v(1981)+v(1989)+v(2001))/10=0.05599261451

The average value of *DE* on local bottoms is

$E^{\min}_{1941-2003}$ =[(v(1941)+v(1945)+v(1950)+v(1955)+v(1962)+v(1973)+v(1978)+v(1986)+v(1998)+v(2003))/10=0.02508267132

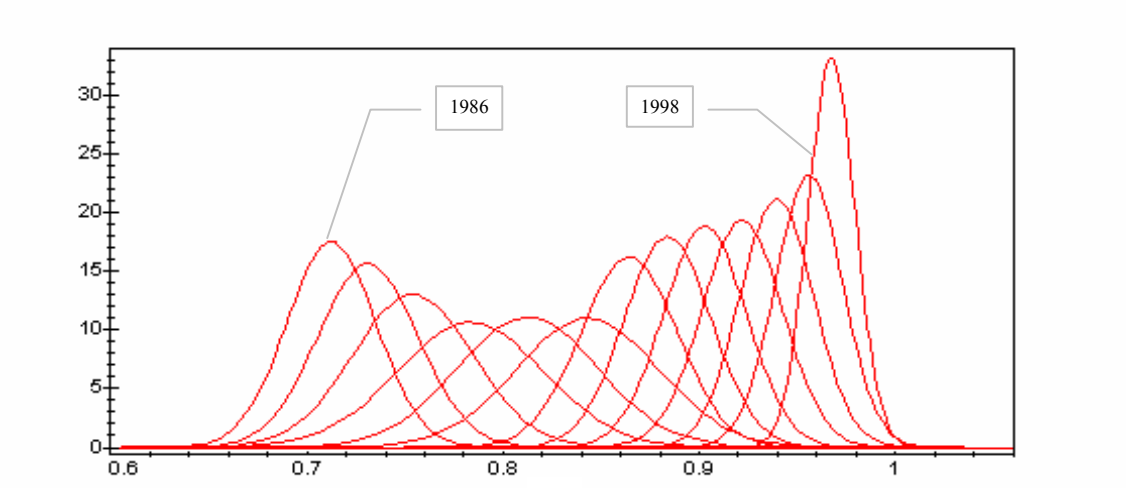

Figure 11 The Partial Distribution curves of US actual economic level on the years between 1986 and 1998

The fluctuating extent of average *DE* is

$$E_{1941-2003} = E^{\max}_{1941-2003} - E^{\min}_{1941-2003} = 0.03090994319$$

Between 1983and 2003:

The average value of *DE* on local tops is

$$E^{\max}_{1983-2003} = [v(1989) + v(2001)]/2 = 0.03013301610$$

The average value of *DE* on local bottoms is

$$E^{\min}_{1983-2003} = [v(1986) + v(1998) + v(2003)]/3 = 0.01692898970$$

The fluctuating extent of average *DE* is

$$E_{1986-2003} = E^{\max}_{1983-2003} - E^{\min}_{1983-2003} = 0.01386861035$$

$$E_{1941-2003} - E_{1986-2003} = 0.01346801871$$

So we have obtained the result that the *DE* fluctuating extent of US economy becomes smaller gradually after 1983, this means the vitality of US becomes lower gradually.

C. Forecast Analysis

Parameters estimating and fitting analysis

we draw the *DE* moving process of US economy between 1998-2003 as figure 12. In figure 12, it is shown that US economy is facing a growth process with *DPE* release. By use of formula (6) and least square method, we get the following estimating expression

$$\bar{v}(t) = e^{6.54770043\ 9 - 10.1188291\ 8\,\bar{\mu}(t)} \qquad (10)$$

By use of $\bar{v}(t) = e^{6.54770043\ 9 - 10.1188291\ 8\,\mu(t)}$, have the estimating values as follows

$\bar{v}$ (2001) =0.02219453168, $\bar{v}$ (2002)=0.01848011202, $\bar{v}$ (2003)=0.01555955669

And the real *DE* values are as follows

v(2001)=0.02286495994, v(2002) =0.01737878060, v(2003)=0.01606046292

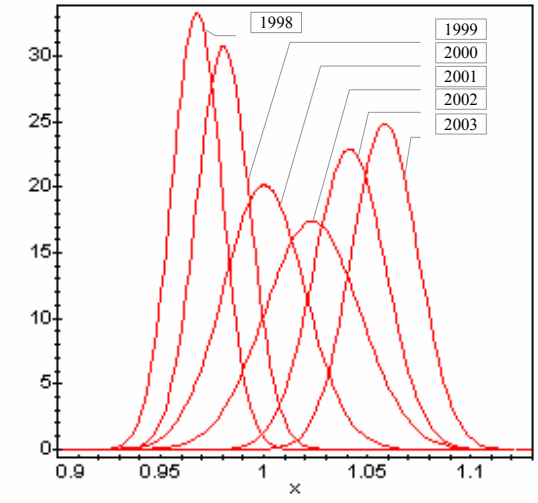

Figure12 the *DE* moving process of US economy between 1998-2003

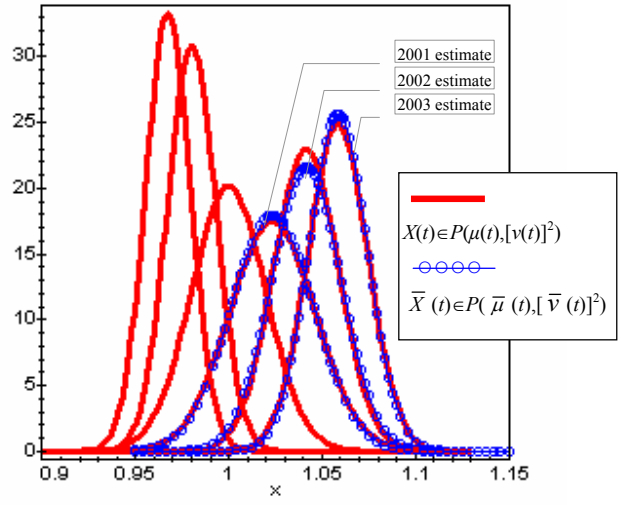

Figure13 The fitting between real *DE* values and estimating values from to 2001-2003

The estimating error is

$$s = \frac{1}{3}\sqrt{\sum_{i=2001}^{2003}[v(t)-\bar{v}(t)]^2} = 0.0004610750723.$$

The fitting between real *DE* values and estimating values is like figure 13.

Forecast analysis

According to equilibrium formula (9) and estimating expression (10), the estimating values of GDP index on 2002and 2003 are as

$\bar{\mu}(2002)$= 1.041205173, $\bar{v}$ (2002) =0.01853532606, and

$\bar{\mu}(2003)$= 1.058690398, $\bar{v}$ (2003) =0.01552960851.

The real values of GDP index on 2002and 2003 are as

$\mu(2002)$= 1.0415, $v(2002)$=0.01737878060

$\mu(2003)$= 1.0585, $v(2003)$=0.01606046292

The average errors are separately as

$$s_{\mu} = \frac{1}{2}\sqrt{\sum_{i=2002}^{2003}[\mu(t)-\bar{\mu}(t)]^2} = 0.0001754810234,$$

$$s_{v} = \frac{1}{2}\sqrt{\sum_{i=2002}^{2003}[v(t)-\bar{v}(t)]^2} = 0.0006362789885,$$

If US government does not implement the important economic measures in next years, we could suppose that the current pattern will maintain, and US economy in recent future could be forecasted on growth process with *DPE* release. Thus, according to equilibrium formula (9) and estimating expression (10), the forecasting data of GDP index from 2004 to 2010 are calculated as in table3.

Table 3 The real and forecasting values of GDP index from 2004 to 2010

Year : t	The real data		The forecasting data		A-C strength
	Basic level : $\mu(t)$	*DPE* : $v(t)$	Basic level : $\bar{\mu}(t)$	*DPE* : $\bar{v}(t)$	k
2002	1.0415	0.01737878060	1.041205173	0.01853532606	37
2003	1.0585	0.01606046292	1.058690398	0.01552960851	53
2004	1.0724*		1.074406847	0.01324627483	69
2005	1.0858*		1.088287333	0.01151052804	85
2006	1.1021*		1.100582771	0.01016394504	101
2007	1.1204*		1.111564463	0.009094999873	117
2008	1.1419*		1.121461560	0.008228286226	133
2009	1.1651*		1.130456722	0.007512416973	149
2010			1.138693925	0.006911636207	165

Explanation : * is the datum estimated by US government

The *DPE* movement process based on forecasting data from 2004 to 2010 is shown in figure 14, and the forecast for US GDP (chained) price index is shown in figure 15.

From figure 15, the development energy of US economy will be lower than the 1955's level, i.e. the lowest in history, after 2008, See also the circle in dotted line in figure 14 and figure 15.

In the figure 15, the forecasting results are in the dotted line circle, F-$\mu(t)$ and F-$v(t)$ are separately the forecasting values for US GDP(chained) price index and the forecasting values for economic development energy.

So the *DE* of U.S. may be released sufficiently between 2008and 2010. According to the *DE* and *DP* theory, U.S. economy will faces two kinds of possible results in the period of 2008-2010, one is another growth process with economic *DP* accumulation starts, and other one would be starting an economic recession process. If economic recession takes place, it should include a recession process with *DP* accumulation and a recession process with *DP* release at least. So it would be a larger scale of recession process. In order to avoid the economic recession, U.S. government needs to do a lot of works, such as technology

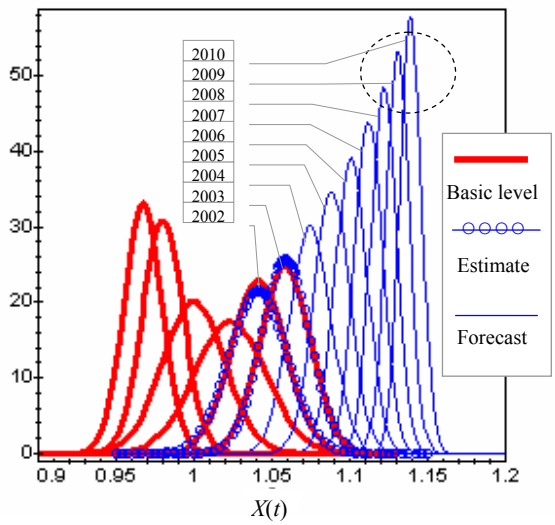

Figure14 The forecast about US economy development from 2004 to 2010

innovation, policy innovation, system innovation, market innovation, etc. , to accumulate the *DP*. If like that, the

workload should be very enormous and egregious, and it may not enough only depending on financial policy.

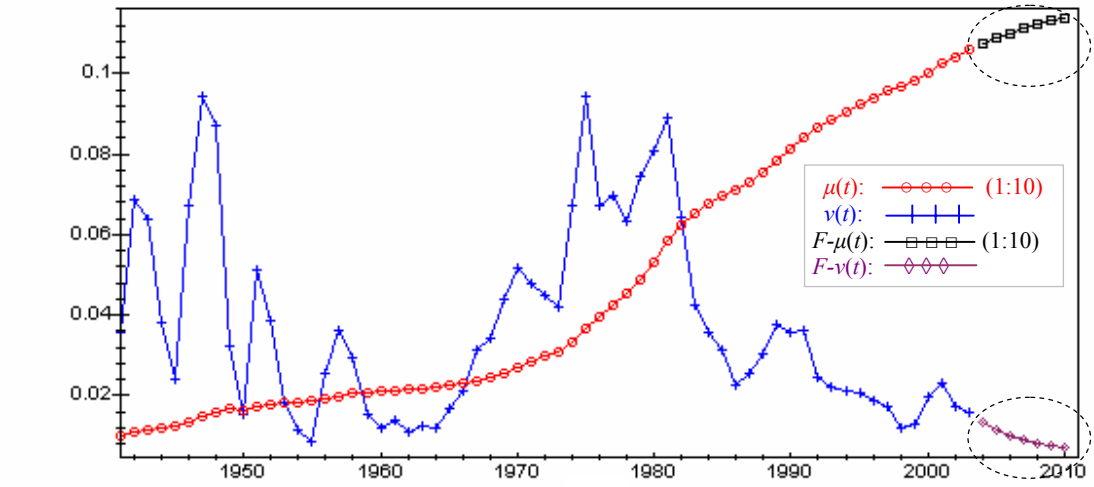

Figure15 The forecasting for US GDP(chained) price index and economic development energy from 2004 to 2010

7 CONCLUSIONS AND COMMENTS

Based on the development power (*DP*) and derivative process [1], We puts forward the concepts of development power in industry (*DPI*) and development power in economy (*DPE*) in this paper, give out development energy (*DE*), the measuring indexes of *DPI* and *DPE* based on Partial Distribution ([2]-[3]), establish the diffusion model for development power in industry, and relational expression of basic level and *DE*, see expression (5) and (6). From [6], we give the forecast method by expression (7), (8) and (9), so the production value, GDP price or others could be forecasted in maximum, minimum and equilibrium. According to [7]-[8], we can analyze and forecast the average value and the most possible value of industrial production and economic GDP.

Based on the conclusions in this paper, we could analyze deeply the movement characters of latent motivity by which the industrial or economic progress is pushed, and know more about the macroeconomic law and future developing of industry and economy, so we could control effectively the industrial and economic development in the reasonable ways.

It is important that the derivative process model, a kind of time series model, could describe clearly the dynamical condition of development in an industry or macroeconomy, namely, we could know that the motivity impelling the industry or economy to progress is strong or weak, and *DP* is accumulating or releasing. If *DP* is accumulating and strong, the production value would grow. If *DP* is releasing and weak, especially at the end of *DP* releasing, the production value is hard to grow. At this time, we need to accumulate *DP* by another way, in order to make the industry or economy progress further.

In a word, the conclusions in this paper are significant to know deeply the macro-regulations of industry and economic developing, to establish industry policies, and to control the developing process of industry or economy.

REFERENCES

[1] Dai, F. Development Power and Derivative Process: A Model and Theory for Macroeconomy Analysis, http://econwpa.wustl.edu: 80/eps /mac/papers/0405/0405013.pdf, 2004.

[2] Dai, F. and Ji, G. A New Kind of Pricing Model for Commodity and Estimating Indexes System for Price Security, *Chinese Journal of Management Science*, 2001, 9(1): 62-69.

[3] Dai, F. and Lu, L. The Investment Analytic Process based on the Partial Distribution, *Chinese Journal of Management Science*, 2001, 9: 315-320.

[4] Dai F., Liang L. The Market Value Analytic Process for Investment Based on the Partial Distribution [C]. Proceedings of SCI 2001/ ISAS 2001, USA.

[5] Dai F., Cheng X., Sun K.. The PD-Fitness Analysis of Price Structures on Chinese stocks Market [C]. Proceedings of SCI 2003, USA.

[6] Dai F., Liu H., Qin Z.F.. Method of Analyzing the Behavour Properties of Stock Price Based on Partial Distribution, *Chinese Journal of Management Science*, 2004, 12(2): 12-16.

[7] Dai, F., Xu, W. X. Liu, H. and Xu, H. A New Kind of method of Optimal Pricing for Commodity. *Chinese Journal of Management Science*, 2003, 11(1): 33-37.

[8] Dai F., Liu H., Qin Z.F. The Model of Optimal Pricing for Assets Based On the Partial Distribution and Its Empirical Research, IEEE-IEMC'2003 Proceedings: 311-315.

[9] http://industry.ccidnet.com/pub/article/c10_a95571_p1.html.

[10] http://www.whitehouse.gov/omb/budget/fy2005/pdf/hist.pdf